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Ozaki

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(54) **METHOD FOR PRODUCING LIQUID DISCHARGE HEAD**

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B41J 2/16 (2006.01)
B41J 2/14 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/1623*** (2013.01); ***B41J 2/14072*** (2013.01); ***B41J 2/1603*** (2013.01); ***B41J 2/1628*** (2013.01); ***B41J 2/1629*** (2013.01); ***B41J 2/1631*** (2013.01); ***B41J 2/1639*** (2013.01); ***B41J 2/1643*** (2013.01); ***B41J 2/1646*** (2013.01); *B41J 2002/14491* (2013.01)

(58) **Field of Classification Search**
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USPC 29/830, 846, 890.1
See application file for complete search history.

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(57) **ABSTRACT**

When the metal constituting a metal layer becoming a diffusion prevention layer is defined as a first metal and the metal constituting a connection terminal is defined as a second metal, in a potential-pH diagram for the first metal-H_2O system, the first metal is present in a passivation area or an insensitive area at a potential of the difference between the standard electrode potentials of the first metal and the second metal in a pH range of 1 to 14.

6 Claims, 8 Drawing Sheets

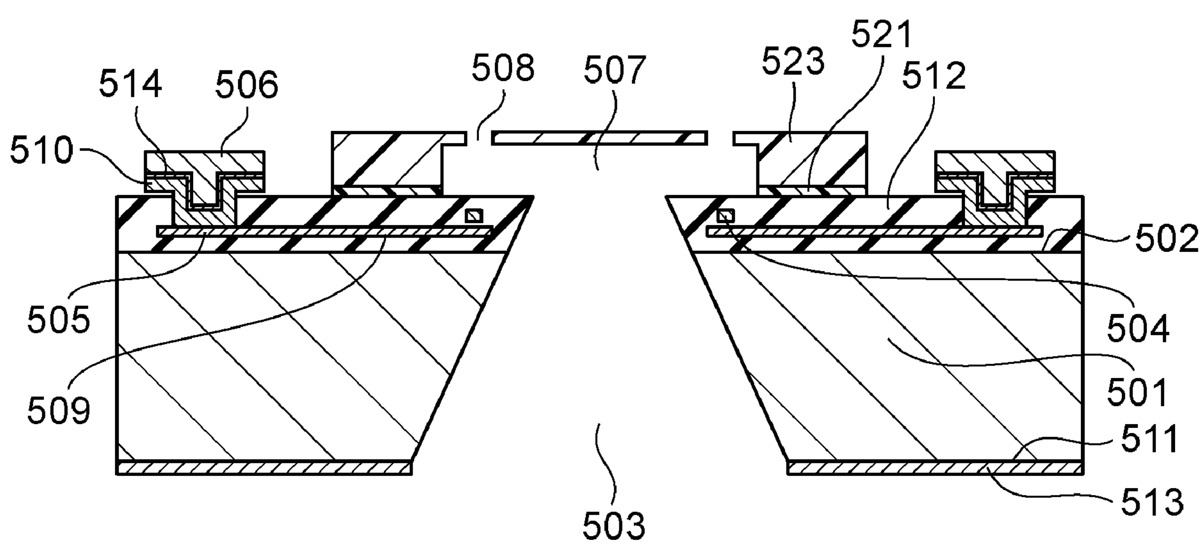
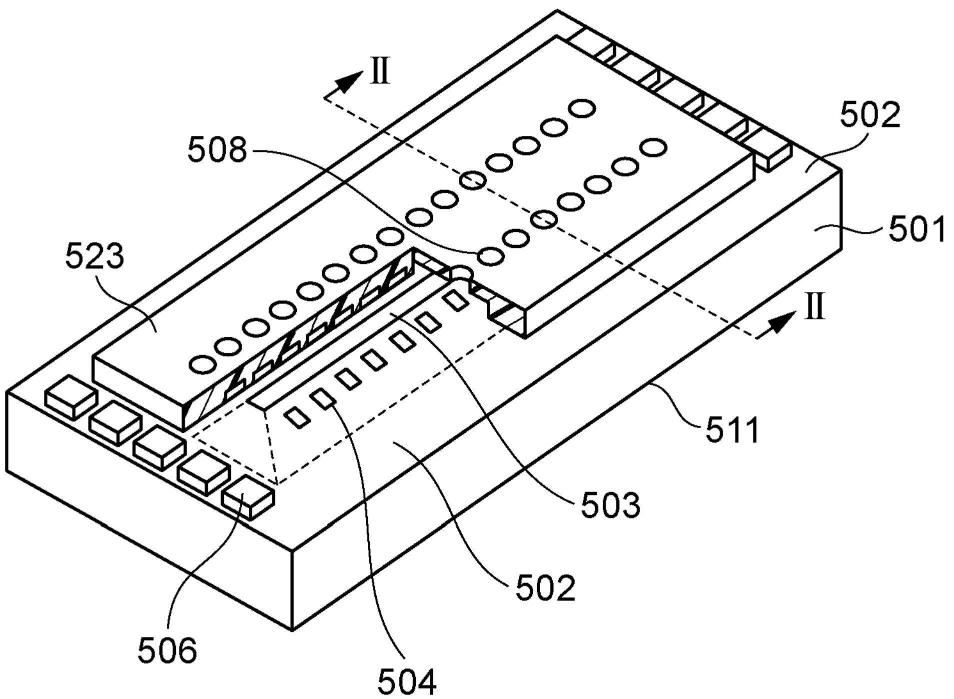
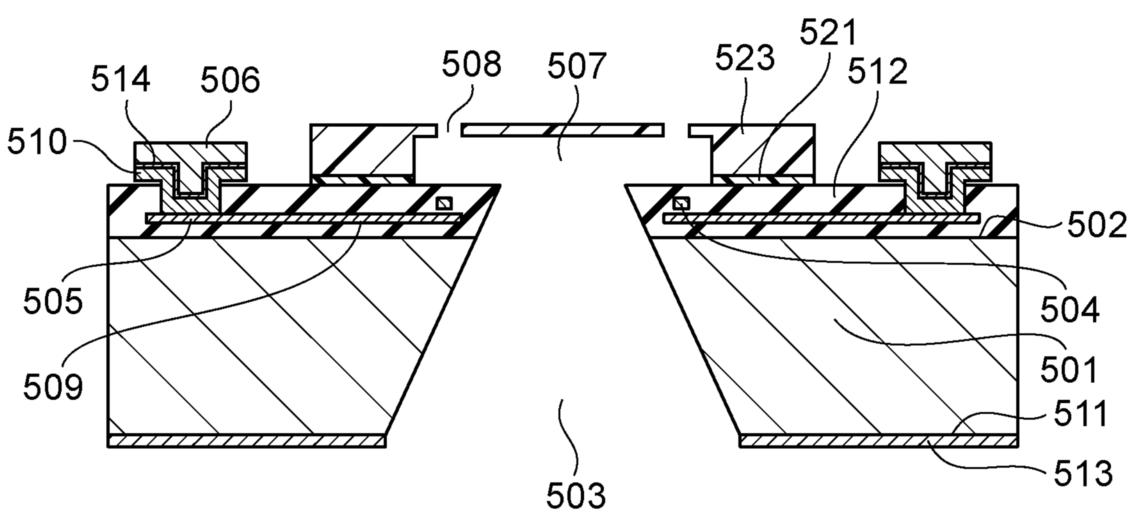


FIG. 1



II
502
508
501
523
II
511
503
502
506
504

FIG. 2



521
514
506
508
507
523
512
510
502
505
504
509
501
511
513
503

FIG. 3A

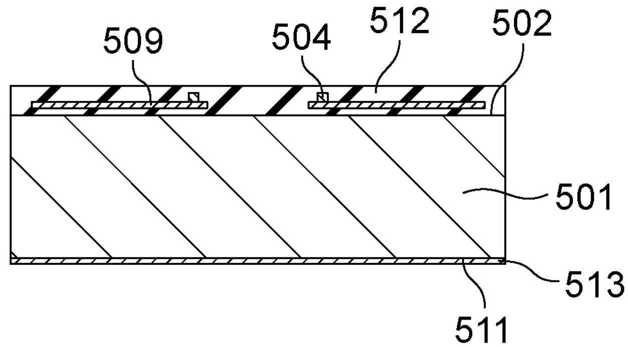


FIG. 3B

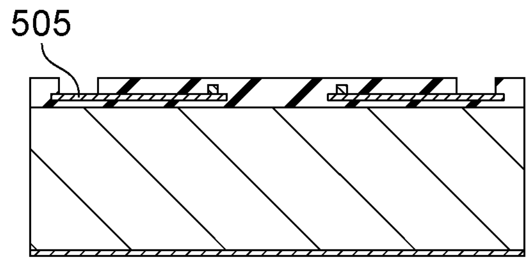


FIG. 3C

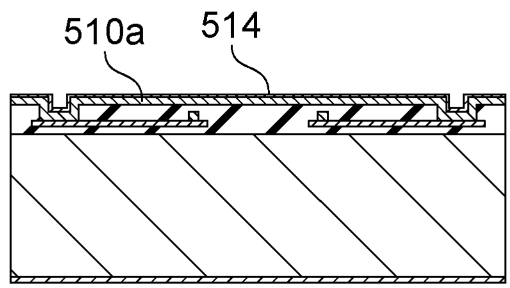


FIG. 3D

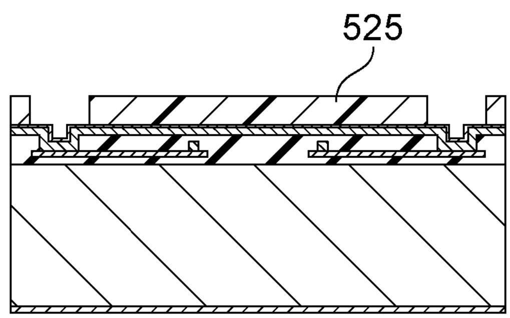


FIG. 3E

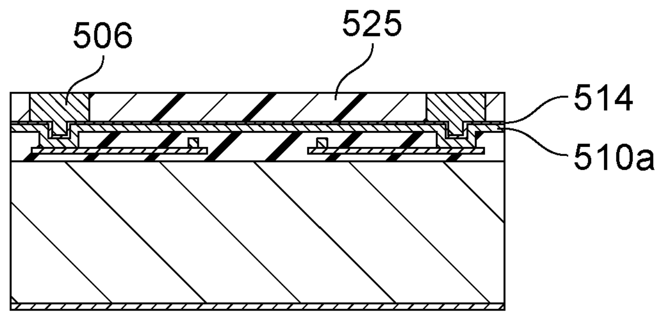


FIG. 3F

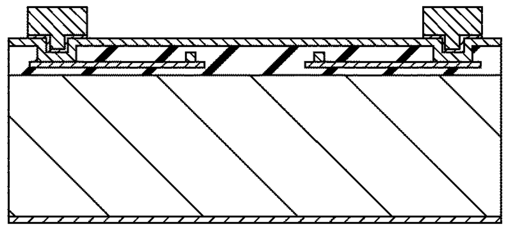


FIG. 3G

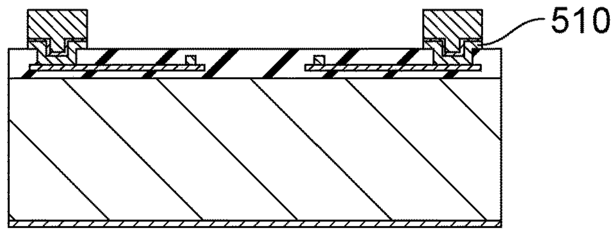


FIG. 3H

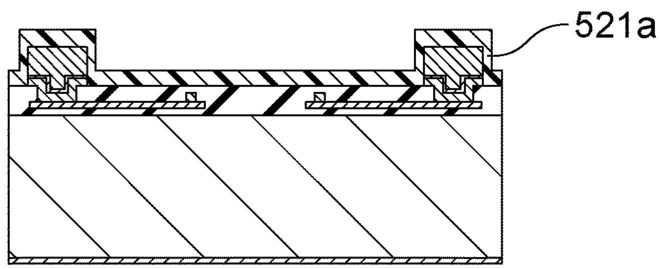


FIG. 3I

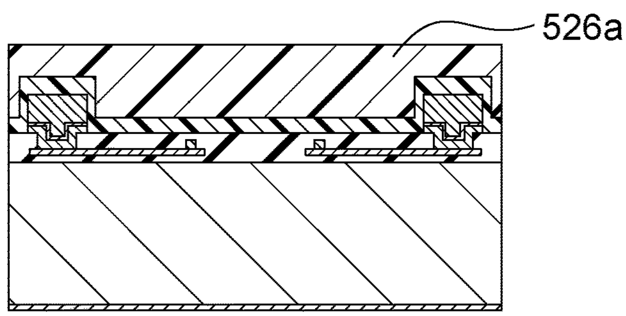


FIG. 3J

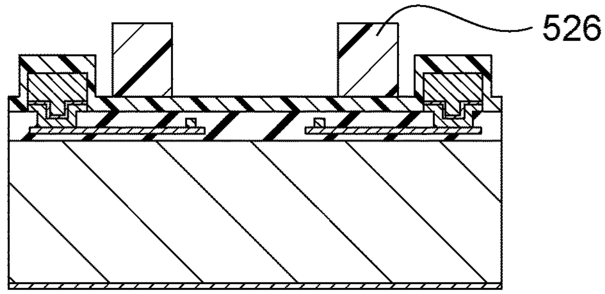


FIG. 4K

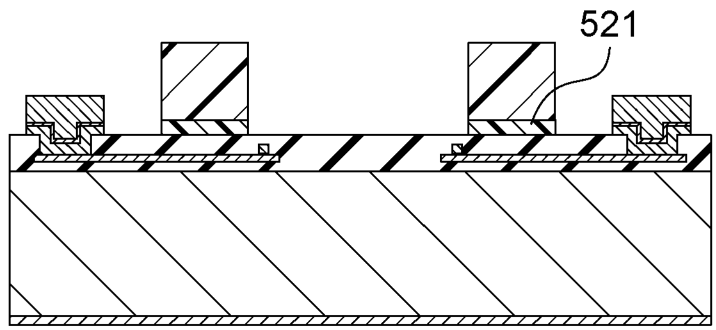


FIG. 4L

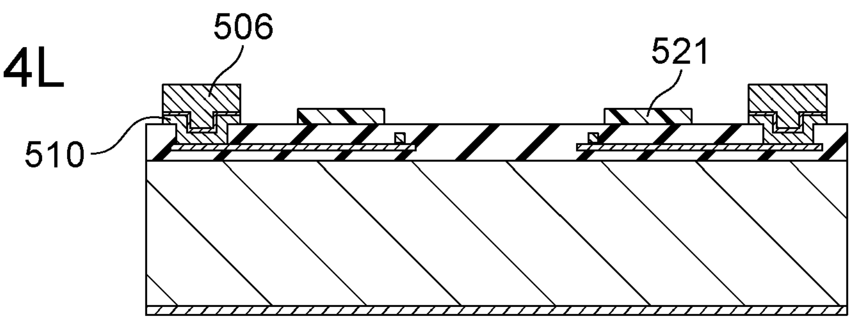


FIG. 4M

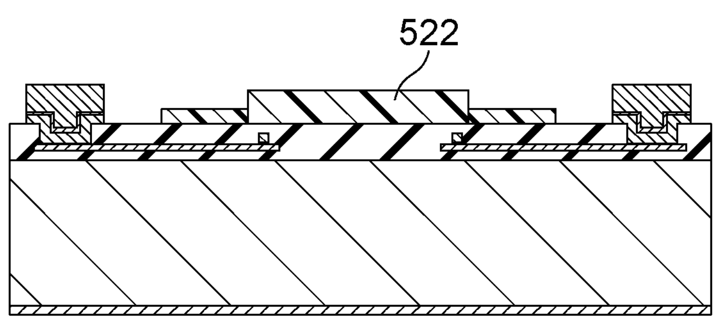


FIG. 4N

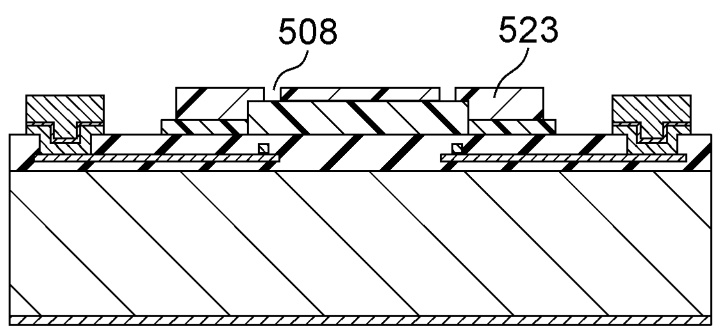


FIG. 4O

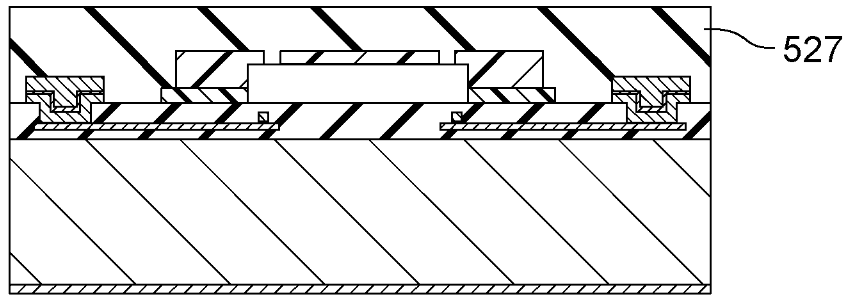


FIG. 4P

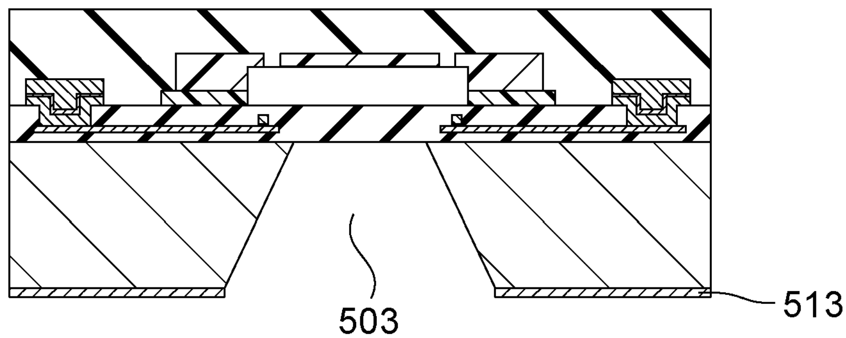


FIG. 4Q

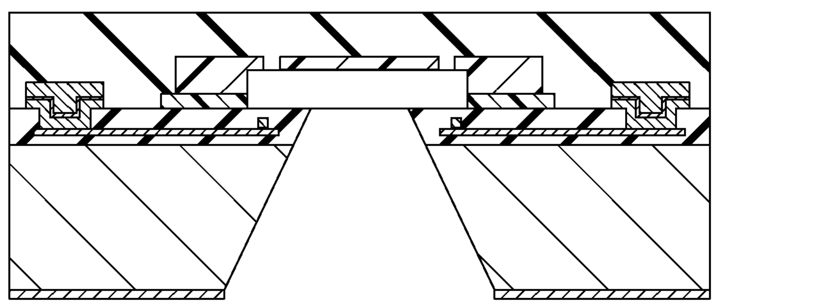


FIG. 4R

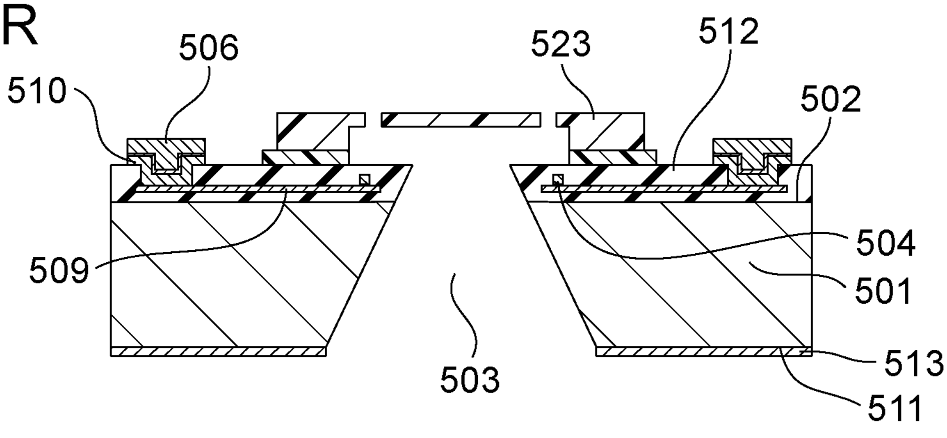


FIG. 5A

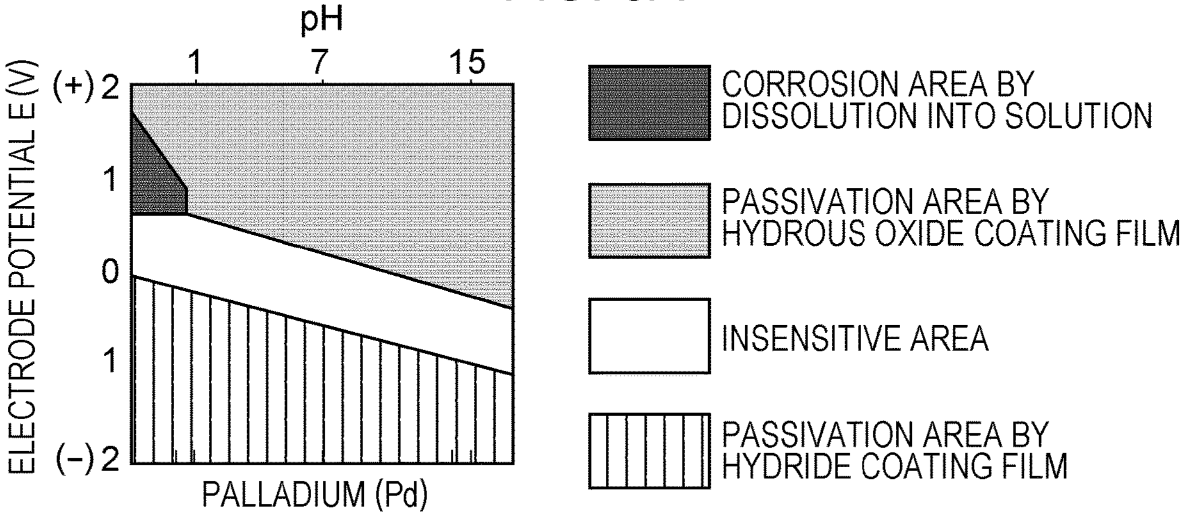


FIG. 5B

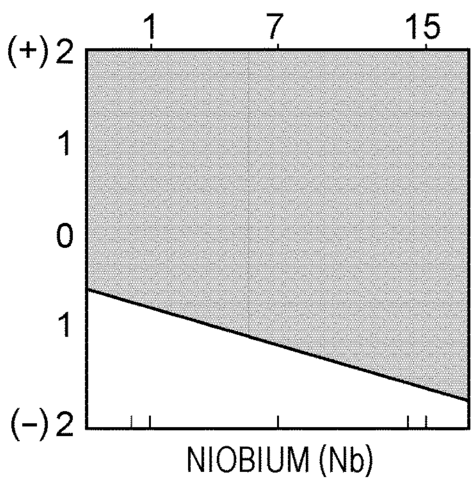


FIG. 5C

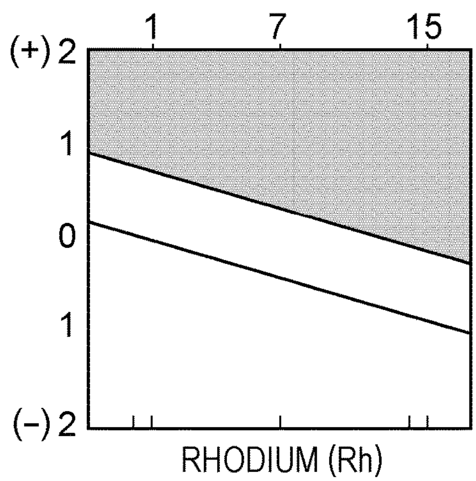


FIG. 5D

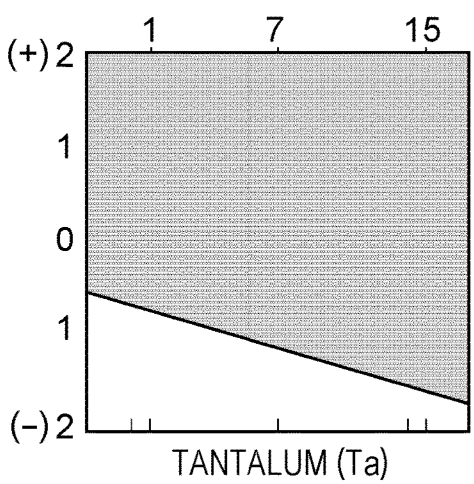


FIG. 5E

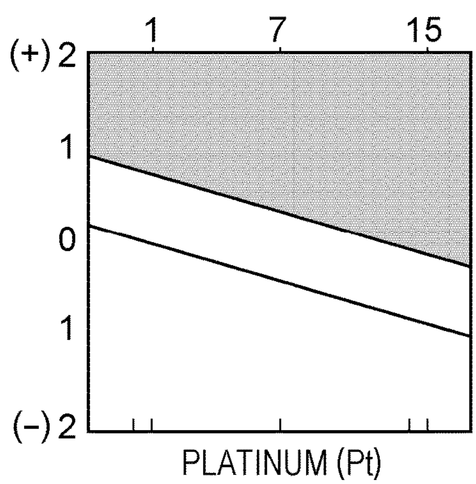


FIG. 6A

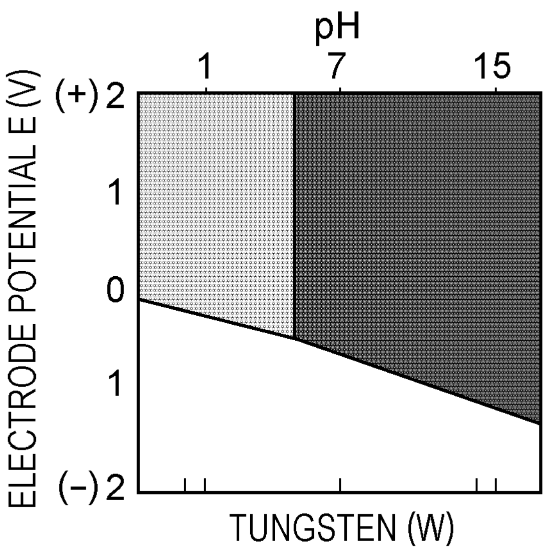


FIG. 6B

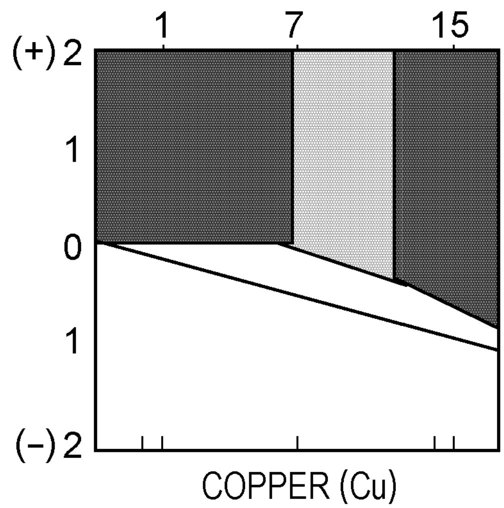


FIG. 6C

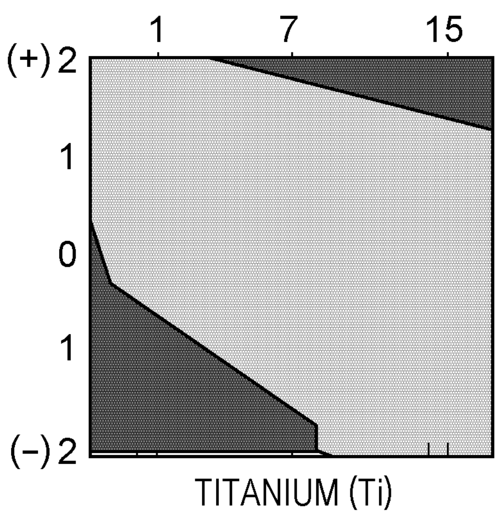


FIG. 6D

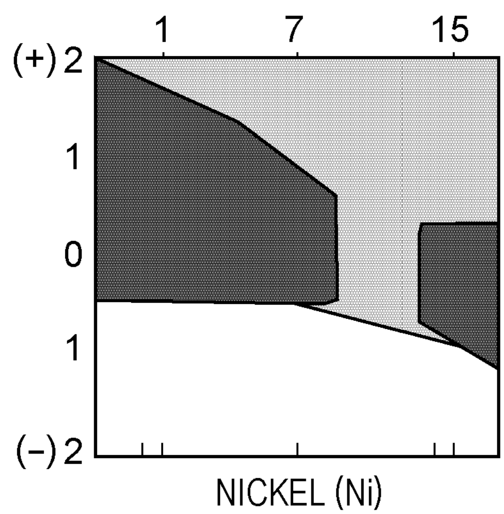


FIG. 7A

Prior Art

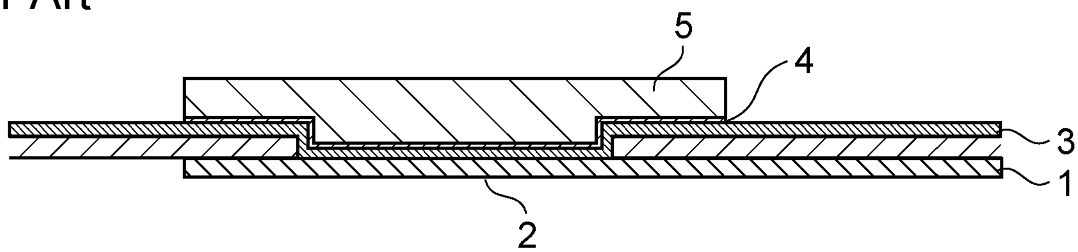


FIG. 7B

Prior Art

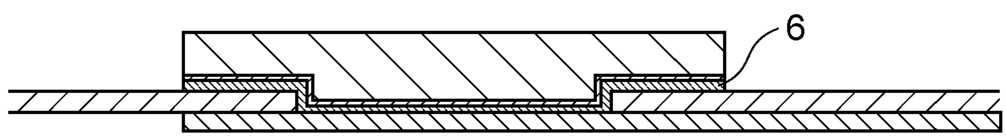
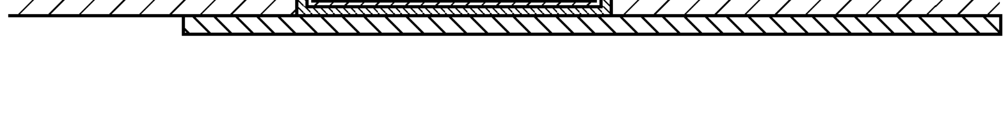


FIG. 7C

Prior Art



METHOD FOR PRODUCING LIQUID DISCHARGE HEAD

BACKGROUND

Field

The present disclosure relates to a production method for forming an electrode on a substrate side for performing electrical connection between a liquid discharge head substrate and the outside.

Description of the Related Art

Some liquid discharge heads, such as an inkjet recording head, include a substrate provided with an energy generating element that generates energy to be used for discharging a liquid and, on the substrate, a channel forming member that forms a discharge opening for discharging a liquid and a channel for supplying a liquid to the discharge opening. In some cases, an internal layer made of, for example, polyimide is disposed between the channel forming member and the substrate for improving the adhesion between the both. An electrical wiring layer for driving the energy generating element is disposed on the substrate. The terminal end of this electrical wiring layer forms an electrode portion, and a bump is disposed on the electrode portion to connect an external power supply source. The bump is usually formed by Au plating. Between the electrode portion and the bump, a diffusion prevention layer made of TiW is disposed for preventing diffusion of Au constituting the bump into the electrode portion constituted of Al and preventing a decrease in reliability of the connection (Japanese Patent Laid-Open No. 2007-251158).

A liquid discharge head having such a structure is produced as follows. An energy generating element and an electrode portion made of, for example, Al are formed on a substrate. Subsequently, a TiW layer, which becomes a diffusion prevention layer on the electrode portion, is formed on the full surface of the substrate. Subsequently, a plating seed layer for forming a bump made of Au is formed on the full surface of the TiW layer. Subsequently, the plating seed layer is masked excluding the region on which a bump is formed, and a bump is formed by making the Au plating grow. Subsequently, the diffusion prevention layer is etched into a shape almost equal to the shape of the bump by using the bump as a mask. A channel forming member is then formed on the substrate to accomplish a liquid discharge head.

SUMMARY

According to the present disclosure, provided is a method for producing a liquid discharge head including a substrate provided with an energy generating element that generates energy to be used for discharging a liquid, an electrical wiring layer electrically connected to the energy generating element, a connection terminal disposed on the electrical wiring layer and performing electrical connection to the outside, and a diffusion prevention layer between the connection terminal and the electrical wiring layer; a channel forming member disposed on the substrate and including a resin forming a liquid flow path; and an intermediate layer disposed between the channel forming member and the substrate. The method includes a step of disposing a metal layer to form the diffusion prevention layer on the substrate; a step of disposing the connection terminal on the metal layer; a step of etching the metal layer with an acid solution using the connection terminal as a mask to form the diffusion prevention layer; a step of forming a layer that becomes the intermediate layer on the substrate provided with the connection terminal and the diffusion prevention layer, providing a pattern of a photoresist on the layer becoming the intermediate layer, etching the layer becoming the intermediate layer using the pattern as a mask to form the intermediate layer, and peeling the pattern with an alkaline solution; and a step of forming the channel forming member on the intermediate layer, wherein when the metal constituting the metal layer becoming the diffusion prevention layer is defined as a first metal and the metal constituting the connection terminal is defined as a second metal, in a potential-pH diagram for the first metal-H_2O system, the first metal is present in a passivation area or an insensitive area at a potential of the difference between the standard electrode potentials of the first metal and the second metal in a pH range of 1 to 14.

In addition, provided is a liquid discharge head having a substrate provided with an energy generating element generating energy for discharging a liquid, a connection terminal electrically connected to the energy generating element and performing electrical connection to the outside, and a diffusion prevention layer between the connection terminal and the substrate, wherein when the metal constituting the diffusion prevention layer is defined as a first metal and the metal constituting the connection terminal is defined as a second metal, in a potential-pH diagram for the first metal-H_2O system, the first metal is present in a passivation area or an insensitive area at a potential of the difference between the standard electrode potentials of the first metal and the second metal in a pH range of 1 to 14.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an example of a liquid discharge head according to an embodiment.

FIG. **2** is a cross-sectional view of the liquid discharge head shown in FIG. **1**.

FIGS. **3**A to **3**J are diagrams explaining each step of a method for producing a liquid discharge head according to an embodiment.

FIGS. **4**K to **4**R are diagrams explaining each step of the method for producing a liquid discharge head according to the embodiment.

FIGS. **5**A to **5**E are potential-pH diagrams for each metal.

FIGS. **6**A to **6**D are potential-pH diagrams for each metal.

FIGS. **7**A to **7**C are diagrams explaining an undercut that can be formed in the diffusion prevention layer.

DESCRIPTION OF THE EMBODIMENTS

In the case of using TiW described in Japanese Patent Laid-Open No. 2007-251158 as a diffusion prevention layer as a lower layer of a bump made of Au, since the ionization tendency of TiW is higher than that of Au, TiW may be excessively dissolved, by galvanic corrosion, in various solutions with which TiW comes into contact in subsequent processes. A case that causes this phenomenon will be described using FIGS. **7**A to **7**C. FIG. **7**A illustrates a state in which a TiW layer **3** becoming a diffusion prevention layer is formed on an electrode portion **2** connected to an electrical wiring layer **1** and a bump **5** is formed on the TiW layer **3** by Au plating using a plating seed layer **4** before etching the TiW layer **3**. Subsequently, as shown in FIG. **7**B, a diffusion prevention layer **6** is formed by etching the TiW layer **3**. On this occasion, as the etchant for the TiW layer **3**, for example, an acidic hydrogen peroxide solution is used. However, since the ionization tendency of TiW is larger than that of Au, the etching rate of TiW becomes extremely high by the galvanic corrosion due to the difference in the standard electrode potentials. As a result, as shown in FIG. **7**C, an undercut of the diffusion prevention layer **6** occurs. Various solutions used in subsequent processes, for example, in the step of forming a channel forming member, readily enter the undercut portion **7**. Accordingly, the occurrence of an undercut has a risk of contamination of the substrate.

In addition, in the production process of the liquid discharge head, in addition to this step, a variety of solutions can come into contact with the bump and the diffusion prevention layer being in an overlapping state. For example, the solutions used in the step of forming an intermediate layer for enhancing the adhesion between the substrate and the channel forming member comes into contact with them. In the step of forming an intermediate layer, as a mask for forming the layer becoming the intermediate layer into a desired shape by etching, a resist pattern is formed on the layer becoming the intermediate layer by photolithography. This resist pattern is usually removed with a resist peeling solution after the etching. As this resist peeling solution, an alkaline solution is usually used, and the contact with this alkaline solution may cause a risk of an undercut of TiW.

An aspect of the present disclosure provides a method for producing a liquid discharge head, in which occurrence of an undercut by excessive etching of the diffusion prevention layer can be prevented.

<Structure of Liquid Discharge Head>

Prior to the description of the method for producing a liquid discharge head according to an embodiment, the structure of a liquid discharge head to which the method for producing a liquid discharge head according to the embodiment can be applied will be described.

FIG. **1** is a perspective view of an inkjet recording head as a liquid discharge head. FIG. **2** is a cross-sectional view of the inkjet recording head in a cross section perpendicular to the substrate through the line II-II of FIG. **1**.

The liquid discharge head includes a substrate **501** that has energy generating elements **504** generating energy to be used for discharging a liquid and a channel forming member **523** that forms a pressure chamber **507** having discharge openings **508** for discharging a liquid and energy generating elements **504** therein.

As the substrate **501**, a silicon substrate can be used. On the surface **502** of the substrate **501**, the energy generating elements **504** are disposed. Examples of the energy generating element **504** include a thermoelectric conversion element, such as a heater, and a piezoelectric element. Connection terminals (bumps) **506** electrically connected to the energy generating element **504** via an electrical wiring layer **509** are further disposed on the surface **502** of the substrate **501**. The connection terminals **506** are disposed on the electrical wiring layer and has a role of performing electrical connection to the outside.

A plurality of the connection terminals **506** are arranged on each end, along the arraying direction of the discharge openings **508**, of the surface **502** of the substrate **501**. The connection terminal **506** plays a role of connecting the substrate **501** to an external power supply source, and the energy generating element **504** is driven by the power supplied from the outside. A protective film **512** made of SiN, SiO, or the like for covering and protecting the energy generating element **504** and the electrical wiring layer **509** may be further disposed on the surface **502** of the substrate **501**.

A diffusion prevention layer **510** is disposed between the electrical wiring layer **509** and the connection terminal **506** for preventing the diffusion of the metal constituting the bump into the electrode portions **505**.

Here, a metal selected as the metal constituting the diffusion prevention layer **510** satisfies the following conditions:

The metal constituting the diffusion prevention layer **510** is defined as a first metal, and the metal constituting the connection terminal **506** is defined as a second metal. Here, in a potential-pH diagram for the first metal-H_2O system, the first metal is present in a passivation area or an insensitive area at a potential of the difference between the standard electrode potentials of the first metal and the second metal in a pH range of 1 to 14.

In the process of producing a liquid discharge head, the diffusion prevention layer **510** and the bump **506** in an overlapping state may come in contact with solutions in a wide pH range from acidic to alkaline. In order to prevent occurrence of galvanic corrosion even if the diffusion prevention layer **510** comes into contact with these solutions, as the metal constituting the diffusion prevention layer **510**, a metal that is passivated or is insensitive in a wide pH range in the potential-pH diagram is selected. The passivation area is a region in the potential-pH diagram where the metal is passivated, and the insensitive area is a region in the potential-pH diagram where the metal is stably present and is hardly corroded.

The method for selecting the first metal constituting the diffusion prevention layer **510** will be described by taking the case where the second metal constituting the connection terminal **506** is Au.

FIGS. **5**A to **5**E and FIGS. **6**A to **6**D are potential-pH diagrams for each metal-H_2O system. The potential-pH diagram is generally used in corrosion and anticorrosion engineering and is a diagram showing the state of a metal due to the potential and pH applied to the metal and is also called Pourbaix diagram.

Pd, Nb, Rh, Ta, and Pt shown in FIGS. **5**A to **5**E all have a passivation area or an insensitive area in the potential-pH diagrams in a wide potential range and a wide pH range of 1 to 14. The difference between the standard electrode potentials of each of these first metals and Au (second metal) is about +0.3 to 2.7 V, and thus there is a difference among the metals. However, from the potential-pH diagram for each metal, in the wide pH range at this potential difference, the first metals are in a passivation area or an insensitive area. This means that even if the both in a contacting state are exposed to an alkaline solution or an acid solution, the first metal is passivated or is insensitive and that galvanic corrosion hardly occurs. Thus, a metal at a potential of the difference between the standard electrode potentials of the first metal and the second metal is present in a passivation area or an insensitive area in the potential-pH diagram in a pH range of 1 to 14 is selected.

In contrast, regarding Ti, which is a component of TiW, shown in FIG. **6**C, although an existing diagram shows only the potential up to 2 V, the difference between the standard electrode potentials of Ti and Au is 3.1 V. It is predicted from FIG. **6**C that since galvanic corrosion proceeds at least in the pH range of 1 to 14, corrosion proceeds in the hydrogen peroxide solution, which is a strong acid, and in the alkaline solution for resist peeling. Regarding W, which is the other component of TiW, the difference between the standard electrode potentials of W and Au is about 1.6 V, and in this case, as shown in FIG. **6**A, corrosion proceeds in the alkaline solution at this potential. As a result, Ti of TiW is eliminated by galvanic corrosion during etching, and at the same time, W is also dissolved. Consequently, in the alkaline solution for resist peeling, the both Ti and W are corroded due to galvanic corrosion with Au. Accordingly, if TiW is employed as the diffusion prevention layer **510** as the lower layer of the connection terminal **506** consisting of Au, an undercut due to galvanic corrosion may disadvantageously occur in the diffusion prevention layer **510**. The potential difference between Cu and Au is 1.2 V, and as shown in FIG. **6**B, corrosion proceeds in solutions of pH 1 to 6.5 and pH 10 to 14. The potential difference between Ni and Au is 1.7 V, and as shown in FIG. **6**D, galvanic corrosion occurs in the alkaline solution for resist peeling. Consequently, it is undesirable to use Ni as the diffusion prevention layer **510**.

The substrate **501** is provided with a liquid supply port **503** passing through from the surface **502** to the back surface **511** of the substrate **501**. The liquid supplied from the supply port **503** to the pressure chamber **507** is given energy generated from the energy generating element **504** in the pressure chamber and is discharged from the discharge opening **508**. An oxide film **513** protecting the substrate **501** may be disposed on the back surface **511** of the substrate **501**.

An intermediate layer **521** having a function of improving the adhesion between the channel forming member **523** and the substrate **501** is disposed between the substrate **501** and the channel forming member **523** disposed on the surface **502** of the substrate **501**. Examples of the material of the intermediate layer **521** include polyetheramide and epoxy resins.

<Method for Producing Liquid Discharge Head>

A method for producing a liquid discharge head according to an embodiment will now be described with reference to drawings. FIGS. **3**A to **3**J and FIGS. **4**K to **4**R are diagrams explaining the method for producing a liquid discharge head according to the embodiment one by one, and the diagrams illustrating each step are cross-sectional views as that in FIG. **2** of the liquid discharge head shown in FIG. **1**.

First of all, as shown in FIG. **3**A, a substrate **501** including an energy generating element **504** and an electrical wiring layer **509** is prepared. A protective film **512** is disposed on the energy generating element **504** and the electrical wiring layer **509**. The back surface **511** of the substrate **501** is covered with an oxide film **513**.

Subsequently, as shown in FIG. **3**B, the protective film **512** is formed into a desired shape by dry etching to expose electrode portions **505**.

Subsequently, as shown in FIG. **3**C, a metal layer **510***a* made of a first metal and a plating seed layer **514** made of a second metal are formed on the surface **502** of the substrate **501**. The metal layer **510***a* is a film becoming a diffusion prevention layer **510**. The metal layer **510***a* and the plating seed layer **514** can be formed by sputtering.

Subsequently, as shown in FIG. **3**D, a plating resist pattern **525** having openings so as to correspond to the electrode portions **505** is formed by photolithography.

Subsequently, as shown in FIG. **3**E, a second metal layer is grown from the plating seed layer **514** in the resist pattern **525** by plating to form connection terminals (bumps) **506** on the metal layer.

Subsequently, as shown in FIG. **3**F, the resist pattern **525** and the plating seed layer **514** are removed. They may be simultaneously removed with a single removing solution or may be sequentially removed with different removing solutions.

Subsequently, as shown in FIG. **3**G, the diffusion prevention layer **510** is etched using the bump **506** as a mask. As the etchant, an acid solution, such as a hydrogen peroxide solution or fluonitric acid, is suitably used. On this occasion, the bump **506** and a side surface of the diffusion prevention layer **510** come into contact with the acid solution. As described above, the first metal constituting the diffusion prevention layer **510** is a metal hardly causing galvanic corrosion with the second metal constituting the bump in an acid environment, and excessive etching of the diffusion prevention layer **510** does not occur to prevent occurrence of an undercut.

Subsequently, as shown in FIGS. **3**H to **3**J and FIGS. **4**K and **4**L, an intermediate layer **521** is formed on the surface **502** of the substrate **501**. Specifically, first of all, as shown in FIG. **3**H, a layer **521***a* becoming an intermediate layer is formed. Subsequently, as shown in FIG. **3**I, a photoresist layer **526***a* is disposed on the layer **521***a* becoming an intermediate layer. Subsequently, as shown in FIG. **3**J, the photoresist layer **526***a* is partially exposed and is then developed to form a resist pattern **526** for forming an intermediate layer. Subsequently, the layer **521***a* becoming an intermediate layer is partially etched to form an intermediate layer **521** having a desired shape as shown in FIG. **4**K. Subsequently, as shown in FIG. **4**L, the resist pattern **526** used in the etching is removed with a resist peeling solution. As the resist peeling solution, an alkaline solution can be used. Commercially available examples of the alkaline resist peeling solution include "Remover 1112A" (manufactured by Rohm and Haas Electronic Materials K.K., trade name). As needed, rinsing with pure water may be further performed. On this occasion, the bump **506** and a side surface of the diffusion prevention layer **510** come into contact with the alkaline solution. As described above, the first metal constituting the diffusion prevention layer **510** is a metal hardly causing galvanic corrosion with the second metal constituting the bump even in an alkaline environment, and excessive etching of the diffusion prevention layer **510** does not occur to prevent occurrence of an undercut.

Subsequently, as shown in FIG. **4**M, a mold material **522**, which will be finally removed for forming a pressure chamber **507**, is formed. The mold material **522** can be formed into a desired shape by patterning using a positive photosensitive resin, such as polymethyl isopropenyl ketone. The mold material **522** can have a thickness of 5 to 70 μm.

Subsequently, as shown in FIG. **4**N, a channel forming member **523** is formed on the intermediate layer and the mold material. The channel forming member **523** can be formed by applying a negative photosensitive resin composition so as to cover the mold material **522** and then forming discharge openings **508** by photolithography.

Subsequently, in the steps shown in FIGS. **4**O to **4**R, a supply port **503** is formed in the substrate **501**. The supply port **503** can be formed by wet etching using a TMAH aqueous solution. First of all, as shown in FIG. **4**O, an etching protective layer **527** is formed so as to cover the surface **502** of the substrate **501**. This etching protective layer **527** plays a role of protecting a variety of members formed on the surface **502** side of the substrate **501** from the etchant in formation of the supply port **503** by wet etching. Examples of the material of the etching protective layer **527** include cyclized rubber. Subsequently, as shown in FIG. **4**P, a supply port **503** is formed by etching the substrate **501** with a TMAH aqueous solution. Subsequently, as shown in FIG.

4Q, the protective film **512** present on the supply port **503** is removed. Subsequently, as shown in FIG. **4**R, the etching protective layer **527** and the mold material **522** are removed by dissolving. Examples of the method for forming the supply port **503** include dry etching such as reactive ion etching, in addition to wet etching.

Finally, an inkjet recording head is accomplished by further curing the channel forming member **523** by baking as needed.

EXAMPLES

A method for producing a liquid discharge head according to an embodiment will now be more specifically described by examples.

First of all, as shown in FIG. **3**A, a substrate **501** having an energy generating element **504** made of TaSiN and an electrical wiring layer **509** made of Al on the surface side was prepared. As the substrate **501**, a (1.0.0) substrate of silicon was used. The energy generating element **504** and the electrical wiring layer **509** were covered with a protective film **512** made of SiN, and the back surface of the substrate **501** was covered with an oxide film **513** made of thermally oxidized silicon.

Subsequently, as shown in FIG. **3**B, the protective film **512** was formed into a desired shape by dry etching using photolithography to expose electrode portions **505**. First of all, a photoresist (manufactured by Tokyo Ohka Kogyo Co., Ltd.) was applied to the surface of the substrate **501** with a thickness of 1 μm by spin coating. A photoresist layer **526*a*** was partially exposed with a pattern mask and an exposure apparatus and was then developed to form a resist pattern so as to correspond to the electrode portions **505** of the photoresist. The protective film **512** was partially etched by dry etching using this resist pattern as a mask to expose the electrode portions **505**. The resist pattern was then removed by ashing with oxygen plasma.

Subsequently, as shown in FIG. **3**C, a metal layer **510*a*** becoming a diffusion prevention layer and a plating seed layer **514** were formed on the surface of the substrate **501**. First of all, a diffusion prevention layer **510** made of Ta was formed with a thickness of 400 nm by sputtering. Similarly, a plating seed layer **514** made of Au was then formed with a thickness of 50 nm.

Subsequently, as shown in FIG. **3**D, a plating resist pattern **525** having openings so as to correspond to the electrode portions **505** was formed using a plating resist (manufactured by Tokyo Ohka Kogyo Co., Ltd.).

Subsequently, as shown in FIG. **3**E, an Au layer was grown from the plating seed layer **514** in the resist pattern **525** by plating to form bumps **506** having a height of 5 μm.

Subsequently, as shown in FIG. **3**F, the resist pattern **525** and the plating seed layer **514** were respectively removed. The resist pattern **525** was peeled off using a resist peeling solution, "Remover 1112A" (manufactured by Rohm and Haas Electronic Materials K.K., trade name). The plating seed layer **514** was removed with an iodine solution. On this occasion, since the etching rate of Au with an iodine solution is low, the thick bumps **506** are hardly etched almost without reducing the thickness, although the thin plating seed layer **514** is removed.

Subsequently, as shown in FIG. **3**G, the diffusion prevention layer **510** made of Ta was etched with fluonitric acid. On this occasion, the bumps **506** made of Au and the side surface of the diffusion prevention layer **510** made of Ta came into contact with the acid solution. However, since Ta is a metal hardly causing galvanic corrosion with Au even in an acid environment, the etching rate is low. Accordingly, no undercut occurred in Ta directly under Au.

Subsequently, as shown in FIGS. **3**H to **3**J and FIGS. **4**K and **4**L, an intermediate layer **521** was formed on the surface of the substrate **501**. Specifically, first of all, as shown in **3**H, a layer **521*a*** becoming an intermediate layer was formed using "HIMAL" (manufactured by Hitachi Chemical Company, Ltd., trade name) with a thickness of 2 μm by spin coating. Subsequently, as shown in FIG. **3**I, a photoresist manufactured by Tokyo Ohka Kogyo Co., Ltd. was applied on the layer **521*a*** becoming an intermediate layer with a thickness of 5 μm by spin coating to form a photoresist layer **526*a***. Subsequently, as shown in FIG. **3**J, the photoresist layer **526*a*** was partially exposed and then developed to form a resist pattern **526** for forming an intermediate layer. Subsequently, the layer **521*a*** becoming an intermediate layer was partially etched by dry etching to form an intermediate layer **521** having a desired shape as shown in FIG. **4**K. Subsequently, as shown in FIG. **4**L, the resist pattern **526** used for the etching was removed with an alkaline resist peeling solution, "Remover 1112A" (manufactured by Rohm and Haas Electronic Materials K.K., trade name), and the resist peeling solution was further rinsed with pure water. On this occasion, the bumps **506** made of Au and the side surface of the diffusion prevention layer **510** made of Ta came into contact with the alkaline resist peeling solution. However, since Ta is a metal hardly causing galvanic corrosion with Au even in an alkaline environment, no undercut occurred in Ta directly under Au.

Subsequently, as shown in FIG. **4**M, a mold material **522**, which would be finally removed for forming a pressure chamber **507**, was formed. Specifically, first of all, polymethyl isopropenyl ketone was applied on the substrate **501** with a thickness of 20 μm by spin coating. Subsequently, the coating film was partially exposed with an exposure apparatus "UX-3300" (manufactured by Ushio Inc., trade name) and then developed into a desired shape. The exposure light was Deep-UV light of 400 nm or less, and the exposure dose was 5000 J/m^2. After the development, baking was performed at 50° C. for 5 minutes.

Subsequently, as shown in FIG. **4**N, a channel forming member **523** was formed on the substrate **501**. Specifically, first of all, a photosensitive resin composition was applied by spin coating so as to cover the mold material **522**. The photosensitive resin composition used was prepared by dissolving an epoxy resin "157S70" (manufactured by Japan Epoxy Resins Co., Ltd., trade name) and a photoacid generating agent "LW-S1" (manufactured by San-Apro Ltd., trade name) in xylene. The thickness of the layer of the photosensitive resin composition was 10 μm above the pressure chamber **507** and was 15 μm in the other region. Subsequently, the layer of the photosensitive resin composition was partially exposed with an exposure apparatus "FPA-3000i5+" (manufactured by CANON KABUSHIKI KAISHA, trade name) and then developed to form a discharge opening **508**. The exposure wavelength was 365 nm, and the exposure dose was 20 J/cm^2. After the development, baking was performed at 90° C. for 5 minutes.

Subsequently, a supply port **503** was formed by the steps shown in FIGS. **4**O to **4**R. First of all, as shown in FIG. **4**O, an etching protective layer **527** was formed so as to cover the surface of the substrate **501**. Cyclized rubber was applied with a thickness of 40 μm by spin coating and was then cured by baking at 90° C. for 30 minutes. Subsequently, as shown in FIG. **4**P, the substrate **501** was etched to form a supply port **503**. First of all, a photoresist "PMER" (manufactured by Tokyo Ohka Kogyo Co., Ltd., trade name) was applied to the back surface of the substrate **501** with a thickness of 1 μm by spin coating and was then exposed and developed to form a resist pattern for etching the oxide film **513**. The oxide film **513** was partially removed with buffered hydrofluoric acid using this resist pattern as a mask to form an opening in the oxide film **513** so as to correspond to the position at which a supply port **503** would be formed. After removal of the resist pattern, a supply port **503** was formed by anisotropic etching using an aqueous solution of 20% TMAH heated to 83° C. Subsequently, as shown in FIG. **4**Q, the protective film **512** present on the supply port **503** was removed with buffered hydrofluoric acid. Subsequently, as shown in FIG. **4**R, the etching protective layer **527** was dissolved and removed in xylene, and the mold material **522** was dissolved and removed in methyl lactate.

Subsequently, the channel forming member **523** was further cured by baking at 200° C. for 1 hour to accomplish an inkjet recording head.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2017-226897 filed Nov. 27, 2017, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A method for producing a liquid discharge head comprising a substrate provided with an energy generating element that generates energy to be used for discharging a liquid, an electrical wiring layer electrically connected to the energy generating element, a connection terminal disposed on the electrical wiring layer and performing electrical connection to the outside, and a diffusion prevention layer between the connection terminal and the electrical wiring layer;

a channel forming member disposed on the substrate and including a resin forming a liquid flow path; and

an intermediate layer disposed between the channel forming member and the substrate, the method comprising:

disposing a metal layer to form the diffusion prevention layer on the substrate;

disposing the connection terminal on the metal layer;

etching the metal layer with an acid solution using the connection terminal as a mask to form the diffusion prevention layer;

forming a layer that becomes the intermediate layer on the substrate provided with the connection terminal and the diffusion prevention layer, providing a pattern of a photoresist on the layer becoming the intermediate layer, etching the layer becoming the intermediate layer using the pattern as a mask to form an intermediate layer, and peeling the pattern with an alkaline solution; and

forming the channel forming member on the intermediate layer,

wherein when a metal constituting the metal layer becoming the diffusion prevention layer is defined as a first metal and a metal constituting the connection terminal is defined as a second metal, in a potential-pH diagram for a first metal-H_2O system, the first metal is present in a passivation area or an insensitive area at a potential of a difference between a standard electrode potentials of the first metal and the second metal in a pH range of 1 to 14.

2. The method for producing the liquid discharge head according to claim **1**, wherein the first metal is any metal selected from Pd, Nb, Rh, Ta, and Pt.

3. The method for producing the liquid discharge head according to claim **1**, wherein the first metal is any metal selected from Pd, Nb, and Rh.

4. The method for producing the liquid discharge head according to claim **1**, wherein the second metal is Au.

5. The method for producing the liquid discharge head according to claim **1**, wherein the acid solution is fluonitric acid.

6. The method for producing the liquid discharge head according to claim **1**, wherein the intermediate layer is at least of polyetheramide or an epoxy resin.

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